O-02

Novel developments in SPM instrumentation: Interferometer displacement sensor and high-resolution video-rate AFM

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Asylum Research, a division of Oxford Instruments and a manufacturer of the quietest AFM in the market, Cypher^{TM}, has recently presented a novel development for high-resolution AFM, an interferometer displacement sensor (IDS). It adds an independent, quantitative measurement of true cantilever displacement, complementing the standard optical beam deflection (OBD) cantilever tracking scheme. The IDS system adds an external laser Doppler vibrometer (LDV) to the existing optical system and therefore can be used as a secondary channel of information during regular AFM imaging with OBD for the tapping mode or can replace the existing OBD detection system for any contact modes.

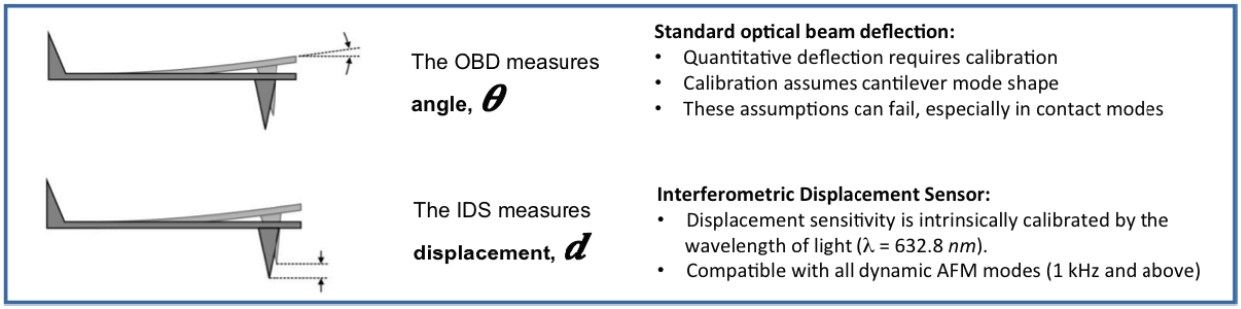

Figure 1. An illustration to the measurement mechanism for OBD and IDS

All research AFMs rely on the OBD for their cantilever deflection signal; it is relatively easy to implement and impressively quiet across a wide dynamic range. However, it is fundamentally a measurement of the changes in angle of the cantilever, and only indirectly related to tip displacement. Interpreting cantilever displacement therefore relies on models of the cantilever mode shape; when the model fails, the measurement is susceptible to errors. Although OBD works remarkably well for certain AFM imaging modes, it is also known to contribute to errors in others. For example, the first research area that was addressed with the IDS option was electromechanics. The result was a remarkable elucidation of the causes of artifacts in quantitative PFM when using OBD (refer to [1] for further detail).

The IDS calibration is based on the wavelength of light (λ=632.8 nm). It can therefore be used to obtain accurate measurements of the true tip displacement across its full measurement bandwidth (1 kHz-2.5 MHz). Furthermore, with a focused spot less than three microns in diameter, the cantilever mode shape can be mapped accurately, enabling quantitative interpretation of AFM experiments with unprecedented precision and accuracy.

The report will also focus on the recent developments in HR video-AFM using Cypher VRS, which was introduced in 2017 and combines video-imaging at up to 625 lines per second with an exceptional ease of use. Various examples from the area of biology and material science will be considered.

1. Labuda, R. Proksch, *Appl. Phys. Lett.* **106**, 253103 (2015).